CONVERTOL PROCESS OF COAL-SLURRY TREATMENT

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INTRODUCTION AND SUMMARY

The Convertol process, recently developed in western Germany, is a new method of cleaning and dewatering coal-washery slurries. It is a modified bulk-oil process, in which a very small quantity of heavy oil is dispersed over the surfaces of the coal particles, followed by a screen centrifuge operation in which the water and dirt (clay, shale, and pyrite particles) are thrown out through the screen perforations and the clean coal particles are retained on the screen and discharged as a dewatered, clean coal product of 8- to 10-percent surface moisture.

It is reported, also, that the process oil, all of which is retained in the clean-coal product, adds to the coking power of the coal and facilitates the production of briquets, reducing the proportions of binding material required.

DESCRIPTION OF PROCESS

The Convertol process was developed by the research staff of Deutsche-Kohlenbergbau-Leitung, the association of coal producers of western Germany. It is essentially a two-step process. The first step is to cover the coal-slurry particles with heavy oil, which is dispersed over the surfaces of the particles. The second step is to separate the oiled coal from the water and dirt by passing it through a conventional centrifugal drier with a perforated screen. Figure 1 shows the generalized flowsheet, with the steps carried out as recommended by the inventors.

A small quantity of heavy oil, such as bunker fuel oil or heavy refinery residue, is mixed with the raw, thickened slurry and sent to an agitating unit. The function of the agitator is to mix the oil and slurry and disperse the oil over the surface of the slurry particles, displacing water with oil films. In this respect the process is similar to the Trent process, except that a very much smaller quantity of oil is used. The inventors report that they have used 2 to 7 percent of oil relative to weight of dry solids in the slurry; but this experience is based entirely on preparation of slurry material for subsequent use in production of coke, and the amount of oil was adjusted to obtain the best coking results. Precise data are yet to be obtained as to the minimum quantity of oil needed for effective cleaning and dewatering.

After this oiling treatment, the slurry is treated in the centrifuge, and the effect there is to discharge the water and dirt through the screen into the effluent and to discharge the clean, dewatered coal as the dried product.

Even this small quantity of oil, when properly dispersed through the slurry, appears to be enough to differentially wet the coal particles of the slurry so that, in the subsequent centrifuging operation, the coal particles have enough cohesion to bridge the perforations in the centrifuge screen and are retained in the machine, whereas the refuse and clay particles not wetted by the oil remain dispersed in the water and pass out with it into the effluent.

The attractive feature of this process, as compared to the Trent process, is that, with the small quantity of oil used, the resulting cleaned coal product is in a free-running condition similar to ordinary commercial fine coal. The Germans report that the centrifuge coal product contains virtually no free refuse material and only 8 to 10 percent of surface moisture. This is a very attractive feature of the process when we consider that the product obtained by treating washery slurries by the present method of froth flotation followed by vacuum filtering generally yields a filter cake of 20 to 25 percent moisture.

EQUIPMENT UNITS

The first step of the process, oiling and dispersing, can be carried out with any kind of high-speed agitator. For instance, for a laboratory demonstration, the process can be carried out in a beaker by agitating the slurry and oil with an egg beater or electric mixer. The second step can be duplicated just by pouring the mixture then into a porous cloth bag and squeezing out the water. The water and clay will come through the meshes as a gray, dirty liquid, and the clean coal will be retained in the bag.

At the first commercial installation, the Pallmann mill is used for the dispersing operation. This is a pulverizing mill that has been manufactured commercially for some years in Germany, and the machines have been sold for grinding coal and other soft nonmetallic minerals. It is somewhat similar to the Braun disk pulverizer commonly used for pulverizing coal samples in the analytical laboratory. It is housed in a shell something like that of a centrifugal pump and contains two rotating disks moving in opposite directions with the circumferential opening adjustable. The feed is introduced axially.

When the slurry is introduced into this mill, the centrifugal action and the rotating disks mix the material violently and, at the same time, throw it under high centrifugal pressure to the perimeter, where it must pass through the narrow circumferential opening. The inventors believe that the centrifugal force is an important factor in forcing rapid dispersion of the oil over the particle surfaces. The mill also crushes any oversize particles that may be in the feed, and it delivers then a product of controlled top size with the oil thoroughly dispersed and ready to enter the centrifuge.

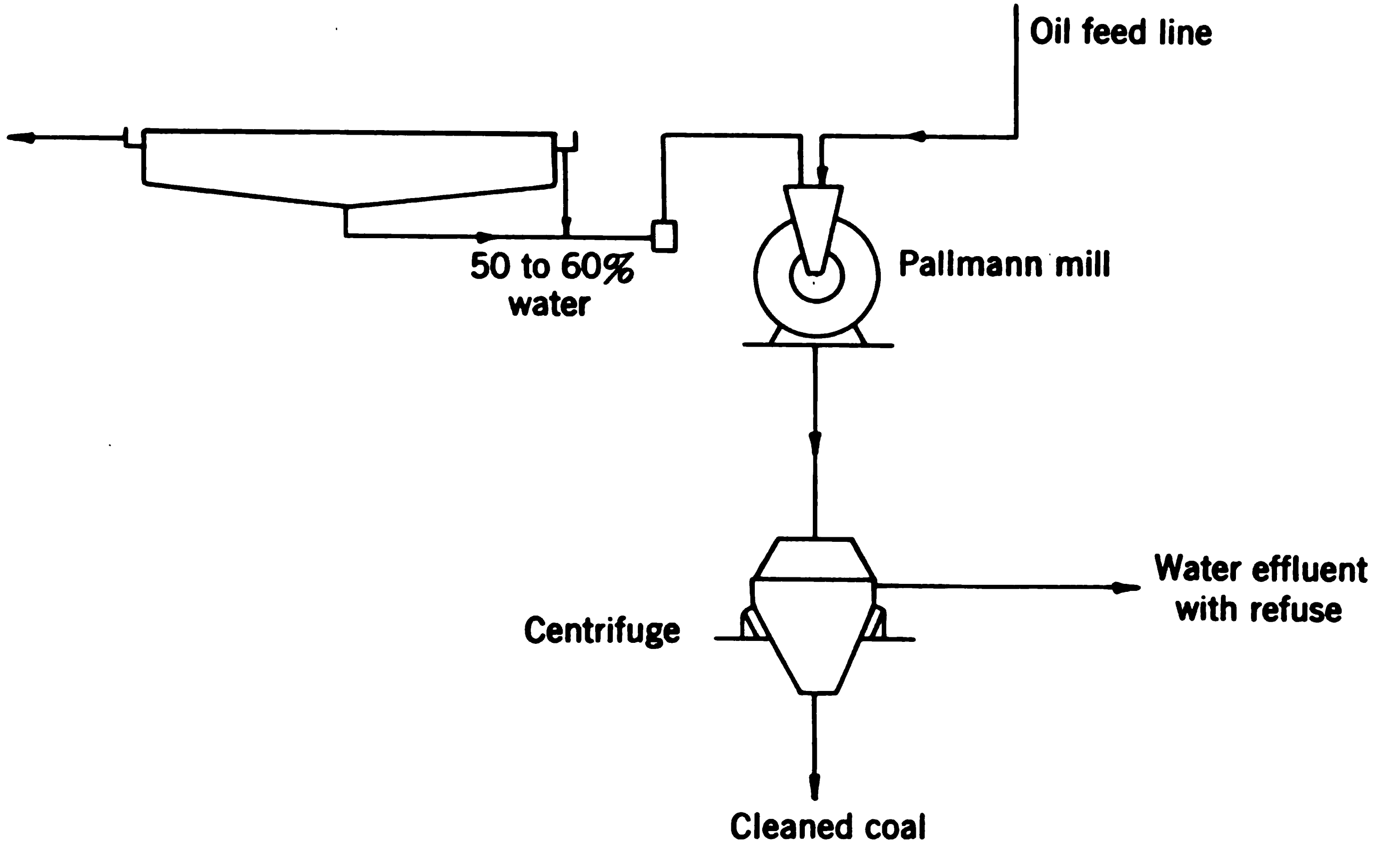

Figure 1. - The preferred arrangement of the Convertol system.

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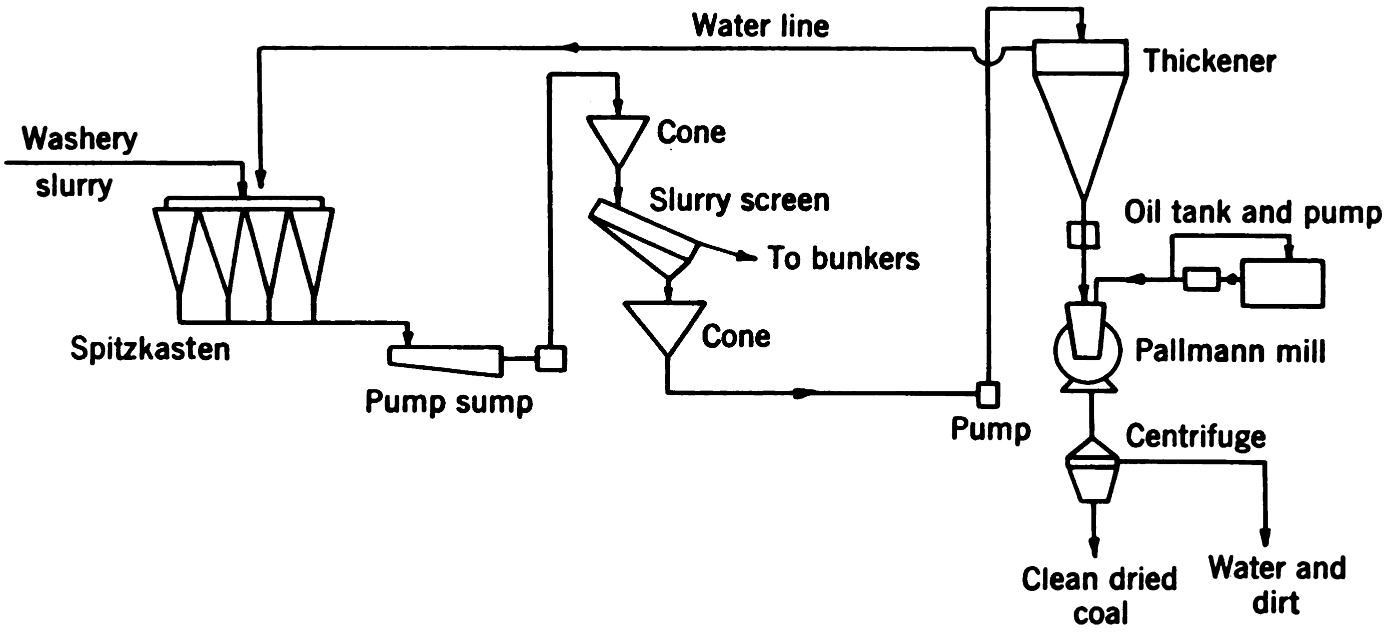

Figure 2 - The Convertol plant of Hanover Colliery near Essen.

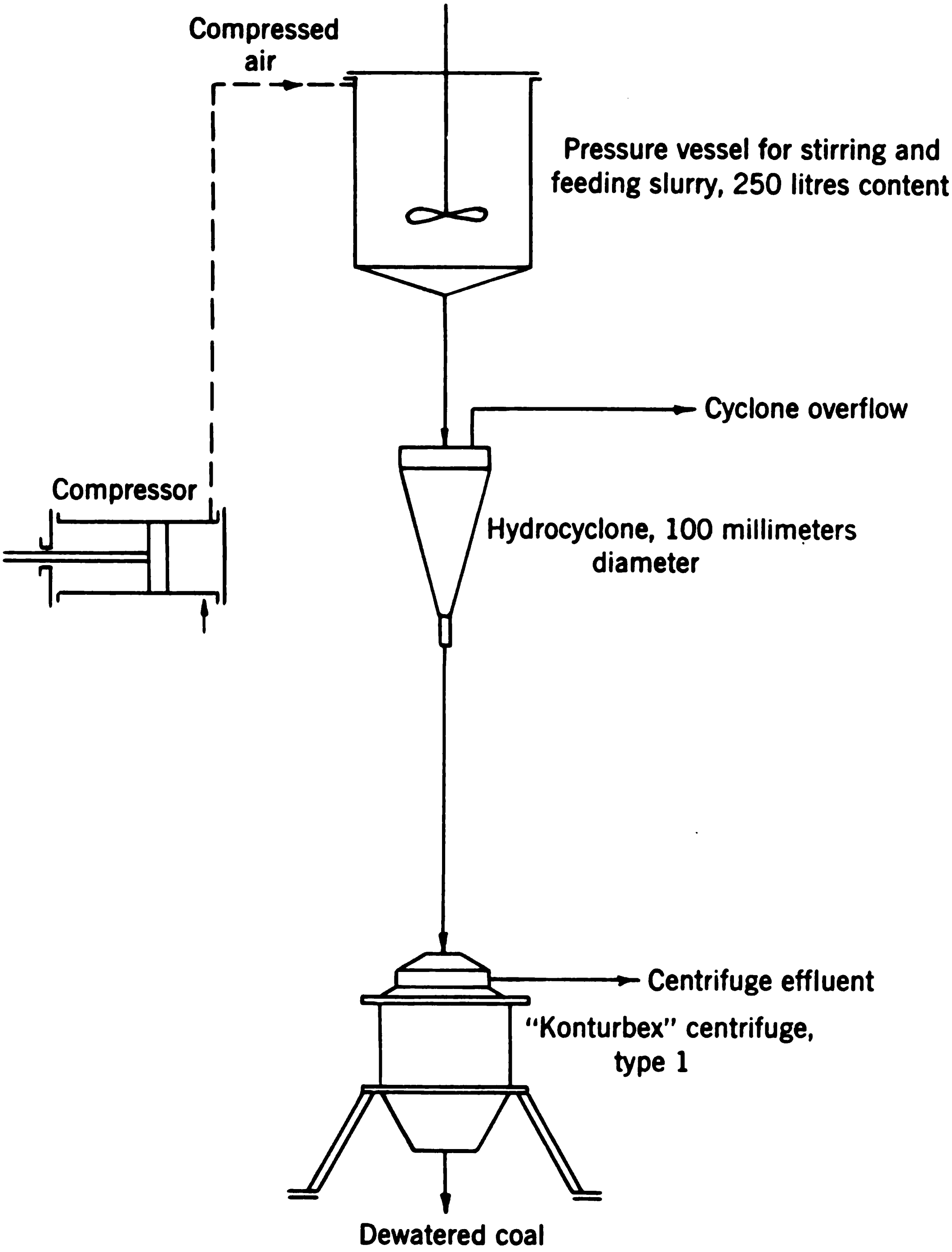
Compressed air
Pressure vessel for stirring and feeding slurry, 250 litres content
Cyclone overflow
Compressor
Hydrocyclone, 100 millimeters diameter
Centrifuge effluent
"Konturbex" centrifuge, type 1
Dewatered coal

Figure 3. - Convertol test plant of Siebtechnik A. G., Mulheim-Ruhr.

In the development and pilot-plant work that Deutsche Kohlenbergbau-Leitung has carried on with this process, it has used two centrifuges, one called the Konturbex, manufactured by Siebtechnik, a small manufacturer of screens and centrifuges with a plant and laboratory in Mulheim-Ruhr, the other by Trennt Technik of Duisburg-Meiderich. These are small centrifuges originally manufactured for use in the chemical industries for such purposes as dewatering ammonium sulfate crystals. However, they do not differ substantially from our centrifuges of American manufacture. The screen surfaces for the rotating baskets are of thin metal plate with round hole perforations reported to be of 0.2 millimeter size or 0.5 millimeter size when used for the Convertol process.

CONVERTOL PLANT AT HANOVER COLLIERY

The staff of Deutsche-Kohlenbergbau-Leitung developed the process in its experimental laboratory in Essen and has a small demonstration plant in which a high-speed electric mixer is used for dispersing the oil.

A semicommercial pilot plant has been installed in the washery at the old Hanover Colliery about 5 kilometers from Essen. A flowsheet of this installation is shown in figure 2. Most of the items in this flowsheet are the original washery items that are indicated in the flowsheet to show the source and nature of the raw material treated in this experimental installation. Figure 3 shows the flowsheet of the Convertol test plant of Siebtechnik A. G. at Mülheim in the Ruhr.

The feed to the Convertol plant at Hanover is the slurry of the washery water from the Hanover preparation plant in which the coal is treated in Baum jigs and the sludge is thickened in Spitzkasten. The Spitzkasten equipment is a device that has been used for at least 50 years in European coal-washing plants. The dilute wash water and sludge goes to these Spitzkasten, which consist of a series of conical or pyramidal tanks in which the solids settle to the bottom and are drawn out through valves at the apex of the cones.

The pumps, conical tanks, etc. shown in figure 2 are simply items of equipment that were introduced into the plant to gather this partly thickened sludge and deliver it to the Convertol equipment in form suitable for treatment.

After the experimental work at Hanover demonstrated the effectiveness of this slurry-treatment method, it was incorporated into commercial operation of the plant and is now operating more or less continuously in production.

In this plant, which consists of the intermediate-size Pallman mill and the corresponding Konturbex centrifuge, washery sludge is treated at the rate of about 4 tons of dry solids per hour. The thickened sludge varies from 30 to 50 percent solids as delivered to the Pallmann mill. The operators say that the sludge concentration is important mainly in affecting the throughput of the plant, since the capacity of the centrifuge varies inversely as the amount of water that has to be handled; but, they say performance is satisfactory in the above range of water content of the feed. It would appear logical to expect that, with extreme dilution of the feed, the centrifuge would tend to pass some fine coal through the screen into the refuse.

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The operators report that, in this installation, the sludge is well cleaned and virtually free from separate refuse particles and that the moisture of the product varies from 8 to 10 percent. The feed is from a medium-volatile coal of low moisture content, perhaps 1.5 percent.

Pilot-plant tests of two other Ruhr washery slurries gave the cleaning and dewatering results shown in tables 1 and 2. These two raw-material lots differed greatly in characteristics. Table 1 shows a very coarse slurry with an average of 20 percent ash content, and table 2 shows a much finer material, with an average of 27.1 percent ash content.

TABLE 1. - Pilot-plant test of coarse washery slurry

Screen analysis of raw slurry			
Size, mm.	Weight-percent	Ash, percent	Test results
+1.0 mm.	14.7	3.2	Raw coal
1.0 x 0.5	34.4	6.4	22 percent volatile matter
0.5 x 0.3	19.2	17.1	20 percent ash
0.3 x 0.15	15.3	37.7	3.0 percent oil used
0.15 x 0.10	1.2	42.2	Products
0.10 x 0.075	2.8	44.5	7.0 percent coal moisture
0.075 x 0.06	2.0	42.8	7.9 percent ash
-0.06	10.4	50.3	Refuse
			87 percent ash

TABLE 2. - Pilot-plant test of fine washery slurry

Screen analysis of raw slurry			
Size, mm.	Weight-percent	Ash, percent	Test results
+1.0 mm.	1.6	13.3	Raw coal
1.0 x 0.5	9.2	3.8	34.4 percent volatile matter
0.5 x 0.3	10.7	4.2	27.1 percent ash
0.3 x 0.2	8.1	6.1	10.0 percent oil used
0.2 x 0.15	7.6	9.3	Products
0.15 x 0.10	6.6	13.3	11.0 percent coal moisture
0.10 x 0.075	3.8	16.5	8.2 percent ash
0.075 x 0.06	6.0	16.8	Refuse
- 0.06	46.4	48.0	91 percent ash

This treatment is reported to add substantially to the coking power of the coal and also to reduce the amount of binder needed if the recovered coal product is later to be made into briquets. No data are yet available in the United States.

The percentage of oil added in the German tests was established by considering the amount needed for these end uses of the coal. For this reason, the data and oil use are not necessarily significant with respect to cleaning. However, the oil consumption will vary in some measure with the average particle size of the raw material.